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## **Haddock**

by

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The haddock, *Melanogrammus aeglefinus*, is a demersal gadoid species distributed on both sides of the North Atlantic. In the western North Atlantic, haddock range from Greenland to Cape Hatteras. Highest concentrations off the U.S. coast are associated with the two major stocks located on Georges Bank and in the southwestern Gulf of Maine. Haddock are most common at depths of 45 to 135 m (25 to 75 fathoms) and temperatures of 2° to 10°C (36° to 50°F). Haddock exhibit age-dependent shifts in habitat use with juveniles occupying shallower water on bank and shoal areas, and larger adults associated with deeper water. Adult haddock do not undertake long migrations, but seasonal movements occur in the western Gulf of Maine, the Great South Channel and on the northeast peak of Georges Bank. Haddock prey primarily on small invertebrates, although adult haddock will occasionally consume fish.

Growth and maturation rates of haddock have changed significantly over the past 30 to 40 years. During the early 1960s, all females age 4 and older were fully mature, and approximately 75% of age 3 females were mature. Presently, growth is more rapid, with haddock reaching 48 to 50 cm (19-20 in.) at age 3; and nearly all age 3 and 35% of age 2 females are mature. Although early maturing fish increase spawning stock biomass, the degree to which these younger fish contribute to reproductive success of the population is uncertain. Spawning occurs between January and June, with peak activity during late March and early April. An average sized (55 cm, 22-in.) female produces approximately 850,000 eggs, and larger females are capable of producing up to 3 million eggs annually. Spawning concentrations occur on eastern Georges Bank, to the east of Nantucket Shoals and along the Maine coast. Juvenile haddock remain pelagic for several months before settling to the bottom.

The U.S. fishery for haddock is managed under the New England Fishery Management Council's Multispecies Fishery Management Plan (FMP). Under this FMP haddock are included in a complex of 15 groundfish species which have been managed by time/area closures, gear restrictions, minimum size limits, and, since 1994, direct effort controls including a moratorium on permits and days-at-sea restrictions under Amendments 5 and 7. Amendment 9 established biomass rebuilding targets, and defines control rules that specify target fishing mortality rates and

corresponding rebuilding time horizons. The goal of the management program is to reduce fishing mortality to levels that will allow stocks within the complex to initially rebuild to above minimum spawning biomass thresholds, and ultimately to remain at or near target biomass levels. The Canadian fishery on Georges Bank is managed under an individual quota system, and Canadian waters on Georges Bank are closed to groundfishing annually from January until June.

The principal commercial fishing gear used to catch haddock is the otter trawl. Recreational catches are insignificant. Total landings (U.S. and Canada) from the Georges Bank and Gulf of Maine haddock stocks increased from 2,700 mt in 1994 to 6,200 mt in 1998 primarily due to increases in stock abundance. United States landings increased from less than 300 mt in 1994 to 2,800 mt in 1998.

## **Gulf of Maine**

Commercial landings of Gulf of Maine haddock declined from about 5,000 mt annually in the mid-1960s to less than 1,000 mt in 1973. Landings subsequently increased sharply to an annual average of 7,000 mt from 1980 to 1983 but declined to record lows in the mid-1990s. Since 1994, commercial landings have increased and were 1,000 mt in 1998. However, commercial landings remain far below both historical landings and potential yield for this stock. Recreational catches have declined and since 1981 have been insignificant. Virtually all landings from this stock are now taken in the U.S. fishery.

The NEFSC autumn bottom trawl survey biomass index declined steadily since 1978, and between 1989 and 1992 fell to a new record low every year, reaching 0.1 kg per tow in 1992. The index has since increased; and values for 1996-1998 are the highest since 1985. However, current indices are less than 20% of the level observed prior to collapse of this stock.

The sharp decline in landings during the mid-1980s to early 1990s, and the corresponding decline in the autumn survey index, reflect the depleted state of this stock. Although recent increases in landings and survey indices reflect increased stock sizes, abundance and biomass levels remain far below pre-collapse levels.

The status of this stock is assessed based on research vessel survey biomass indices. Overfishing is assessed based on a proxy for fishing mortality that evaluates the ratio of total catch to the stock biomass as estimated by research vessel surveys. The most recent assessment indicates that the stock is in an overfished condition and that overfishing has been occurring with reference to the Amendment 9 MSY-based harvest control rule.

### Summary Status

Long-term potential catch (MSY)	= 2,400 mt
Biomass corresponding to MSY <sup>1</sup>	= $B_{MSY}$ proxy = 8.25 kg/tow
Minimum biomass threshold	= 4.38 kg/tow
Stock biomass in 1998	= 3.03 kg/tow (Implies an overfished condition)
$F_{MSY}$ proxy <sup>2</sup>	= 0.29
$F_{TARGET}$ <sup>3</sup>	= 0.20
$F_{TARGET98}$	= 0.00
Overfishing definition	= $F_{THRESHOLD98}$ <sup>4</sup> = 0.00
$F_{1998}$	= 0.21 (Implies overfishing was occurring)
Age at 50% maturity	= 1.8 years, males 2.2 years, females
Size at 50% maturity	= 30 cm (11.8 in.), males 39 cm (15.4 in.), females
Assessment level	= Yield per Recruit
Management	= Multispecies FMP

**M = 0.2**

**F<sub>0.1</sub> = 0.24**

**F<sub>max</sub> = Undefined**

<sup>1</sup> A NEFSC autumn survey biomass index value of 8.25 is used as a proxy for  $B_{MSY}$ .

<sup>2</sup> An exploitation index (catch / NEFSC autumn survey biomass index) equal to 0.29 is used as a proxy for  $F_{MSY}$ .

<sup>3</sup> From lower 80th percentile of  $F_{MSY}$  proxy bootstrap estimates.

<sup>4</sup>  $F_{THRESHOLD} = F_{MSY}$  proxy = 0.29 when biomass proxy is greater than  $B_{MSY}$ ; when biomass proxy is between  $B_{MSY}$  and the minimum biomass threshold,  $F_{THRESHOLD}$  is the maximum F that allows rebuilding to  $B_{MSY}$  in five years; when biomass proxy is less than the minimum biomass threshold,  $F_{THRESHOLD} = 0.00$ .

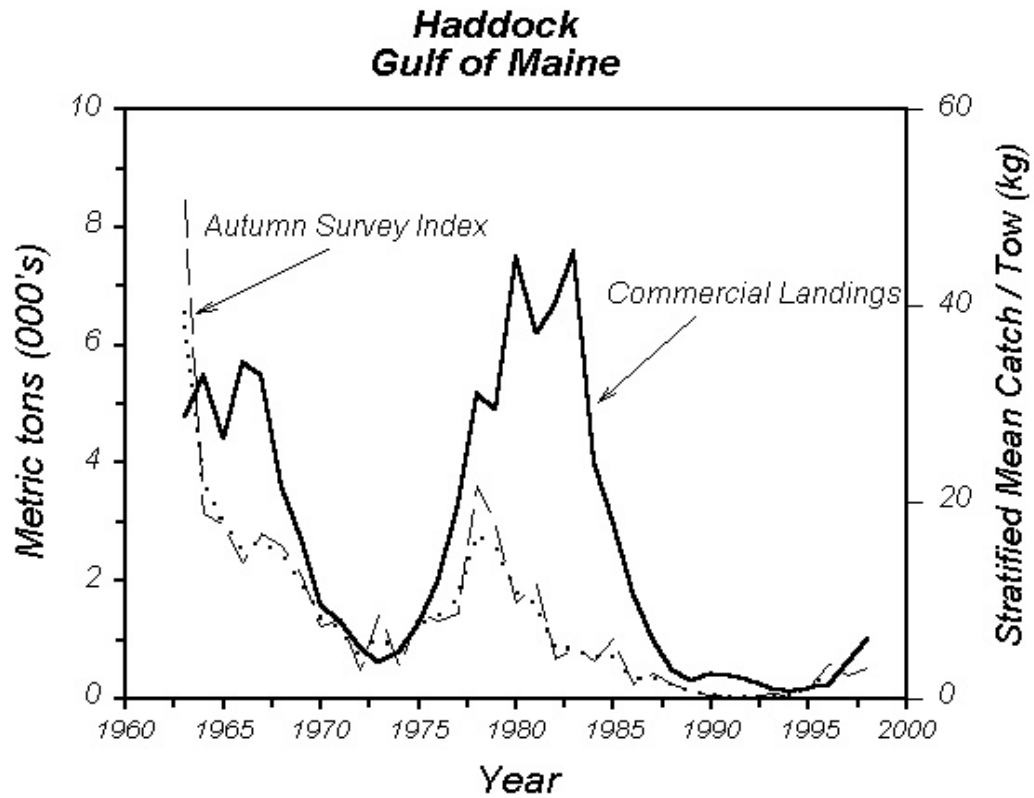


Table 2.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year										
	1979-88 Average	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
U.S. recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial											
United States	3.8	0.3	0.4	0.4	0.3	0.2	0.1	0.2	0.3	0.6	1.0
Canada	0.6	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-	-
Total nominal catch	4.4	0.3	0.4	0.4	0.3	0.2	0.1	0.2	0.3	0.6	1.0

## Georges Bank

From 1935-1960, Georges Bank haddock stock biomass averaged more than 150,000 mt, which produced stable commercial landings of 40,000 to 60,000 mt. Total commercial landings increased to more than 150,000 mt in 1965 and 121,000 mt in 1966 due to recruitment of the exceptionally strong 1962 and 1963 year classes and intense fishing by distant-water fleets. The stock subsequently collapsed, with landings declining to less than 5,000 mt annually during the mid-1970s. Landings increased between 1977 and 1980, reaching 27,500 mt, but subsequently declined to 2,300 mt in 1995. Subsequently, total landings have increased to 5,200 mt in 1998. In that year, the U.S. fishery accounted for approximately 35% of total landings, and Canadian landings accounted for 65%.

The NEFSC autumn bottom trawl survey indicates that stock biomass declined markedly since the late 1970s. The index reached a historic low in 1991 (0.9 kg per tow), but subsequently increased, owing to recruitment of several moderate sized year classes. The 1998 index value (5.75 kg per tow) is well below levels observed in the 1960s and mid- to late 1970s.

Population estimates derived from virtual population analysis indicate that this stock has started to rebuild. Total age 1+ stock size declined from 133 million fish in 1979 to 15 million fish in 1991, but subsequently increased to 41 million fish at the beginning of 1998. Spawning stock biomass declined from 69,000 mt in 1978 to 11,000 mt by 1993, and has since increased to 38,000 mt in 1998. However, spawning stock biomass was still below the minimum SSB threshold level of 53,000 mt, indicating an overfished condition.

Recruitment was poor during most of the 1980s and 1990s. The strongest recent year classes were those of 1983, 1985, 1987, 1992 and 1996, each contributing between 14 to 17 million fish at age 1. However, these year classes were less than one-third the size of the average year classes produced by this stock during the 1930s, 1940s, and 1950s. Fishing mortality on age 4 and older haddock exceeded 0.40 (30% exploitation rate) in 1992-1993, declined to 0.14 (12% exploitation rate) in 1995, and has since remained below the long-term management target ( $F_{\text{TARGET}} = 0.20$ , 16% exploitation rate). Because the Amendment 9 harvest control rule designates a fishing mortality rate of zero at spawning stock biomass levels below 53,000 mt, however, overfishing was occurring for this stock. Improved recent recruitment, coupled with restrictive management measures by the U.S. and Canada, have contributed to the initiation of stock rebuilding.

Observed increases in spawning stock biomass of Georges Bank haddock have resulted from conservation of existing year classes. This is a necessary first step in the stock rebuilding process. Significant rebuilding beyond current stock levels will require improved recruitment above levels observed during the past two decades. Recent research vessel surveys provide indications that the 1998 year class may be the strongest in two decades. If this recruitment is realized, there is a potential for significant stock rebuilding during the next decade.

## Summary Status

Long-term potential catch (MSY)	=	46,000 mt
SSB corresponding to MSY <sup>1</sup>	=	B <sub>MSY</sub> proxy = 105,000 mt
Minimum SSB threshold	=	53,000 mt
SSB in 1998	=	38,100 mt (Implies an overfished condition)
F <sub>MSY</sub> (proxy) <sup>2</sup>	=	0.26
F <sub>TARGET</sub> <sup>3</sup>	=	0.20
F <sub>TARGET98</sub>	=	0.00
Overfishing definition	=	F <sub>THRESHOLD98</sub> <sup>4</sup> = 0.00
F <sub>1998</sub>	=	0.15 (Implies overfishing was occurring)
Age at 50% maturity	=	1.9 years, males 2.2 years, females
Size at 50% maturity	=	34 cm (13.4 in.), males 39 cm (15.4 in.), females
Assessment level	=	Age Structured
Management	=	Multispecies FMP

**M = 0.2**

**F<sub>0.1</sub> = 0.26**

**F<sub>max</sub> = Undefined**

**F<sub>1998</sub> = 0.15**

<sup>1</sup> SSB (here, SSB<sub>MSY</sub>) is used as a proxy for biomass.

<sup>2</sup> F<sub>0.1</sub> is used as a proxy for F<sub>MSY</sub>.

<sup>3</sup> F<sub>TARGET</sub> = 75% of F<sub>MSY</sub> proxy = 0.20 when SSB is greater than SSB<sub>MSY</sub>.

<sup>4</sup> F<sub>THRESHOLD</sub> = F<sub>MSY</sub> proxy = 0.26 when SSB is greater than SSB<sub>MSY</sub>, decreasing linearly from 0.26 at 105,000 mt of SSB to zero when SSB is at or below 53,000 mt. F<sub>TARGET</sub> decreases linearly from 0.20 at 105,000 mt of SSB to zero at 68,000 mt of SSB.

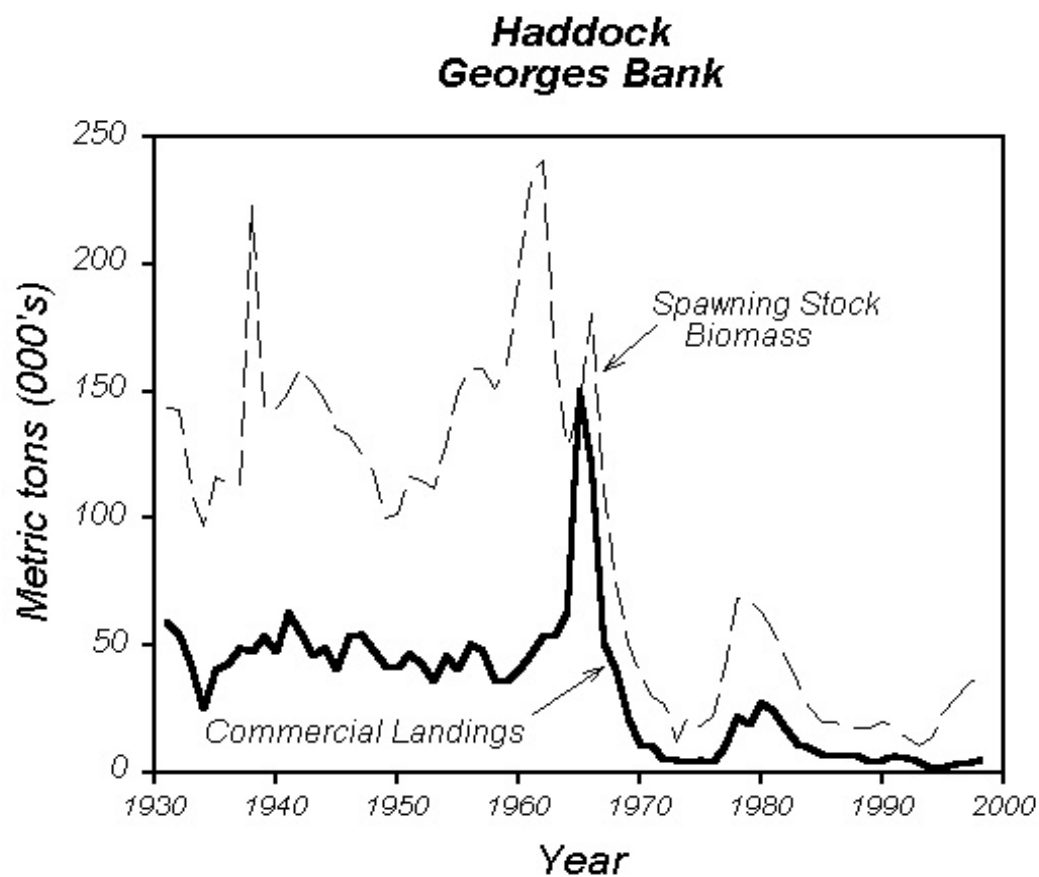


Table 2.2                      Recreational catches and commercial landings (thousand metric tons)

Category	Year										
	1979-88 Average	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
U.S. recreational	0.1	-	-	-	-	-	-	-	-	-	-
Commercial											
United States	9.3	1.4	2.0	1.4	2.0	0.7	0.2	0.2	0.3	0.9	1.8
Canada	4.6	3.1	3.3	5.5	4.1	3.7	2.4	2.1	3.6	2.6	3.4
Total nominal catch	14.0	4.5	5.3	6.9	6.1	4.4	2.6	2.3	3.9	3.5	5.2

**For further information**

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